PIER Energy-Related Environmental Research
Environmental Impacts of Energy Generation, Distribution and Use

Identifying Microclimatic and Flow-level Triggers Associated with the Onset of River Breeding Activities of the Foothill Yellow-legged frog *(Rana boylii)* on the North Fork Feather River, California

Contract #: 500-01-044
Contractor: Garcia and Associates (GANDA)
Contract Amount: $1,987,000 (Full contract amount; only part funded this project.)
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The Issue

Hydropower provides anywhere from 9 percent to 19 percent of the electricity used in California each year. This percentage varies each year, and is dependant on water availability and other factors. Dam operators release increased water flow (pulses) in California rivers not only to generate electricity, but also to control flooding and to facilitate recreational river rafting. These pulsed flows can affect native stream species because the increased frequency of these flows and their late, warm-season timing deviate significantly from the stream's natural seasonal flow, or *hydrograph.*

The foothill yellow-legged frog *(Rana boylii)* is an inhabitant of streams and rivers from Oregon and California and has experienced drastic population declines in some parts of its range. Because of the dynamic nature of river discharge levels, the frogs must select an egg-laying site that prevents their eggs from drying out if flows drop significantly during egg development and prevents their eggs from being washed away if late-season precipitation or unseasonable warming accelerates snowmelt, thereby increasing stream flow strength. The current practice of releasing pulse flows from dams to mimic the natural water flow over time could be inappropriately timed for foothill yellow-legged frogs, and it could present the danger of egg mass scouring or displacement of small-sized tadpoles in early development.

Project Description

This research was part of the collaborative Pulsed Flow Program. The California Energy Commission's Public Interest Energy Research (PIER) Program funded research at the University of California, Davis, to evaluate the effect of pulsed flows on foothill yellow-legged frogs. The aim of this work is to provide hydroelectric power operators with a model that could predict when frogs breed, to minimize negative impacts to these populations.

This study's primary objectives were to determine how local environmental conditions (such as water temperature, stream flow, and precipitation) affect the onset of foothill yellow-legged frog breeding activities and how pulse flows and irregular flow releases associated with high runoff and regulated rivers affect the breeding and movement patterns of adult frogs. The study also

sought to determine how adult foothill yellow-legged frogs use tributaries as movement corridors during the pre-breeding period and how culverts affect foothill yellow-legged frog movements.

Researchers monitored the movements and breeding activities of a population of foothill yellow-legged frogs to determine their relationship to climatic variables in six tributaries and their associated breeding sites on the Poe and Cresta reaches of the North Fork Feather River (NFFR) during spring in 2004 and 2005 by visual surveys and radio telemetry.

PIER Program Objectives and Anticipated Benefits for California

This project offers numerous benefits and meets the following PIER program objective:

- **Bringing environmentally safe energy services and products to the marketplace.** Based on the model of environmental parameters affecting breeding activity, hydroelectric power managers gain information (such as movement dates, temperature and flow preferences) to enhance foothill yellow-legged frog breeding success by preventing sharp fluctuations in the hydrograph during the breeding season from April through June.

Results

Male frogs left tributaries earlier than females and stayed longer at breeding sites. Breeding areas were located along the mainstem river adjacent to the tributaries, and tributaries acted as refugia for most of the year. There was much variation in actual timing; however, day length (i.e., time of year) was the only parameter statistically correlated with initial movements in females. Females moved initially in late April/early May, and mean daily tributary temperatures were above 10°C (50°F) when females left home ranges on tributaries to eventually breed on the NFFR. Oviposition dates were clustered in periods when mean mainstem temperatures were between 10°C (50°F) and 16°C (61°F) and mainstem flow was between baseflow and less than 55% above baseflow. A small percentage of frogs laid eggs at somewhat higher flows, but only during a declining hydrograph. Length of stay by females at river breeding sites was extended by high flows and, on the Cresta Reach, relatively low numbers of males. Late season rains and associated high flows delayed breeding in 2005 when compared to 2004, especially in the Poe Reach—the warmer of the two reaches where breeding typically occurred first.

Final Report

PIER-EA staff intend to post the final report on the Energy Commission website in the summer of 2006 and will list the website link here.

Contact

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